

“A Day in the Life of a NASA Scientist”: An interactive experience for the Goddard Visitor Center.

Abstract:

We propose to create an interactive experience for the Goddard Visitor Center that will inform, inspire, and engage visitors by providing a portal into the daily lives of scientists at GSFC. Through a hands-on experiment visitors will engage in an authentic experience of the work of the Principal Investigators of the science proposal and, as a result, they will experience the excitement that scientists go through in order to make new discoveries. Participants will engage in the work of NASA as they operate an authentic detector to explore the properties of matter analogous to the way that the instrument will be used in space. The instrument team for the two parent science proposals will build the detector and chamber and the EPO lead will implement the exhibit components.

Expertise and/or experience of the PI:

Joanne Hill is a Research Scientist in the Astrophysics Science Division of the Goddard Space Flight Center. She received her PhD in X-ray Astronomy from the University of Leicester (UK) in 1999 and spent 8 years at Penn State University as the Instrument Scientist on the *Swift* X-ray Telescope. Following the launch and the completion of the commissioning of *Swift* (July 2005), she moved to the GSFC to continue her research in instrument development, joining the X-ray Polarimetry group. She is the Principal Investigator (PI) on an Astronomy and Physics Research and Analysis program for the development of “A Gamma-ray Burst Photoelectric Polarimeter” (one of the parent science awards to this proposal). In parallel, she continues to support the *Swift* on-orbit operations and gamma-ray burst research.

From a young age, Joanne was inspired by the exploration of space and it has always been her dream to work for NASA and to become an astronaut. She feels very lucky to have had the opportunity to build an instrument that is in space observing the largest explosions in the universe and now to be at NASA developing instruments to answer new questions. She would like to share her excitement and to use her current work to inspire young people by showing them first hand what NASA scientists do and how an astronomical instrument works by using a real instrument developed in the lab.

Other relevant experience includes teaching undergraduate physics laboratory experiments and mathematic classes when she was a post-graduate student. While working on *Swift* she supervised the day-to-day activities of three postgraduate students and an undergraduate student. While at GSFC she has also participated in the EPO program “Making Girl Scouts ACEs (Astronomical Cosmic Exploration) of Space through Chandra Outreach”.

Expertise and experience of E/PO Lead as related to the activity:

Carmel Conaty is responsible for the Goddard Visitor Center and is the lead for Strategy and Development for Goddard’s Office of Public Affairs, which includes the Office of Education. She is a systems engineer with 18 years of experience at NASA and a 2005

graduate of NASA's Leadership Development Program. While on assignment at NASA HQ in 2004-2005, she served the Exploration Systems Mission Directorate (ESMD) Deputy Associate Administrator, Dr. Terri Lomax, in ESMD Education and Public Outreach (EPO). Results included development of an EPO strategy and framework for ESMD, and review and evaluation of ESMD FY06 proposals.

For the Goddard Visitor Center, she is responsible for all partnerships, programs and development, as well as day-to-day operations and for the Education Resource Center. Her technical background as an engineer with many years of experience working with scientists on in-house flight instruments was the origin of her desire to inspire students and the public by providing engaging and compelling educational experiences that reflect the daily work and value of NASA. She has a long history of support and participation in NASA education and outreach programs and serves on a local private school board.

QUALITY, SCOPE, REALISM AND APPROPRIATENESS

We propose to create an interactive experience for the Goddard Visitor Center (VC) that will inform, inspire, and engage visitors by providing a portal into the daily lives of scientists at the Goddard Space Flight Center (GSFC). This is in full alignment with the VC's mission to engage the public in NASA's vision and the work of GSFC.

To this end, we will build a hands-on exhibit for the VC audience (high-school, middle-school and general public) based on the design of the Time-Projection Chamber polarimeter being developed within the scope of the two parent science projects. The exhibit will provide an opportunity to share the excitement of real instrument development for space applications, and demonstrate how scientists detect astronomical sources. The 'hands-on' activity will demonstrate the interaction of radiation with matter by displaying real-time particle tracks resulting from alpha-particle, beta-particle and X-ray interactions within the detector. Further information is available at:

<http://astrophysics.gsfc.nasa.gov/xrays/inst/polarimetry/epo.html>

Participants will follow a simple step-by-step procedure (the same scientific process followed by NASA scientists) including putting on electrostatic discharge wrist-bands, smocks and cleanroom gloves (not actually required for the exhibit). Participants will learn the importance of following a scientific procedure.

The exhibit will introduce the properties of different types of radiation by allowing the participant to select the type of radiation. The length and the linearity of the track produced will be dependent on the selection. In addition, various types of material will be available for the student to move into and out of the radiation path, demonstrating the stopping power of various materials e.g. paper, aluminum and lead.

The interactions of X-rays in the detector will produce a spectrum and will provide a basis to explain spectroscopy. The absorption of the radiation by different materials will be used to draw a direct parallel to the spectroscopy of an astronomical source where

scientists use the spectrum to determine what kind of absorbing materials exist between the observer and the source, e.g. dust clouds.

A looped professionally produced video recording, approximately 2 minutes in length, of the actual experiment in a GSFC lab, including the scientist's description of the test results will be presented as part of the exhibit. This will have audio and be closed-captioned. Colorful descriptive panels complementing the video will explain what scientific questions will be answered from the operation of this detector in space. These panels will make the direct link between the results of the visitors experience and scientific discovery. Additional information will be made available on the VC website and as handouts at the VC.

As is the case with other VC exhibits, visiting middle and high schools, upon making their initial reservation, will be sent a pre-visit package electronically for the teacher to use to prepare the students for the visit. After the visit, the teachers will be given a post-visit package that includes evaluation. More details on this can be found in the evaluation section.

In addition to the "Day in the Life" exhibit, broader opportunities for students and the general public to interact and make a personal connection with NASA scientists will occur at special events:

- 1) An evening lecture by the PI at the VC to a general informal audience
- 2) Targeted live question and answer sessions at the VC with the female scientist PI and the female engineer EPO Lead including:
 - a. Women in Science. This event will be in partnership with the Woman in Science group whose mission is to encourage and inspire high school girls to pursue careers in science and engineering.
 - b. Goddard Astronomy club
- 3) In order to broaden the impact beyond visitors to the VC, one of the live events will be used to interactively communicate with schools across the country on the Digital Learning Network <http://nasadln.nmsu.edu/dln/>. Archived with this event will be the short video of the experiment with the scientist's description of the detector.

Joanne Hill, the PI, will oversee the team, the building of the detector and its installation and maintenance. Several of the scientists identified as PI/Co-I's on both of the parent proposals (K. Black, P. Deines-Jones and K. Jahoda) will be involved in the design and testing of the detector and the readout electronics. The technician, R. Koeneke, who is supporting the current research program, will be responsible for the manufacture of the detector enclosure and the components and will perform the installation of the detector into the VC. The final installation of the radioactive sources, CO₂ gas cylinders and high-voltages will be overseen by the GSFC radiation branch and safety branch, respectively. See the resource utilization section for details. The implementation of the overall exhibit and educational materials and coordination of the events will be lead by the EPO Lead, Carmel Conaty. Sallie Smith, a NASA GSFC Education Program Specialist, will work

with the science team to create a module that includes pre- and post-classroom activities. She will lead the evaluation and develop “lessons learned”.

The budget is aligned to the workplan and phased with parent research programs. The detector is built in the first year and the remainder of the exhibit is completed in the first 3 months of the second year and is funded for 2 years of operation as seen in the resource utilization section.

CUSTOMER NEEDS/FOCUS

The “Day in the Life” experience is designed to be an informal educational program. This type of exhibit is not currently available at the Visitor Center (VC), but has been identified as a need by our informal survey taken this summer. Visitors, stakeholders and participants at a VC development workshop in October 2006 identified an increased understanding of the work of NASA as a top objective. Every year approximately 36,000 visitors come to the VC because they want to know more about the work of NASA. It is evident from staff interactions with visitors that there is a need to better inform about the types of work that NASA does; this exhibit will help to fulfill this identified need.

The primary audience at the VC is the general public, middle school and high school age groups comprised of approximately 40% middle school students, 25% high school students, 20% adults and 15% elementary students. The top 3 regions for all visitors are Prince George’s county, Baltimore County and Washington DC, and the VC supports an underserved population from those areas. Local schools and Explorer schools will be targeted via flyers, which will be distributed electronically via established education listserves. The VC is located in PG County and this exhibit will serve our local community.

Although this is an informal exhibit, participants will find the program valuable as it will support the teaching of National Science Standards identified under the content section of this proposal.

The NASA funded PIs and Co-Is will provide all of the science content for this exhibit.

PARTNERSHIP/LEVERAGE/SUSTAINABILITY

The “Day in the Life” exhibit is an active partnership between GSFC’s Astrophysics Science Division who will develop the detector and the GSFC Education office, which will implement the exhibit to maximize value to participants. We are leveraging existing materials, expertise, and hardware for the exhibit and the special events. We have received letters of support from the Digital Learning Network (DLN), Women in Science program and the Head of GSFC Education.

The 2 minute video recording, which will be produced by GSFC TV, will leverage existing materials, visuals and expertise and will be archived on the VC homepage and made available for podcast on venues such as YouTube and as a module on the DLN.

The exhibit will permanently reside at the Goddard VC and will be maintained by the Astrophysics Science Division for two years of operation. The exhibit could be used as a model for other NASA visitor centers and museums or could be made available for loan to other institutions.

PROPOSED PROGRAM EVALUATION

The goal of the “Day in the Life” exhibit is to Inform, Inspire and Engage audiences about the work of NASA at the GSFC.

Goal 1: Inform - The interactive exhibit with a video loop of the GSFC scientist and lab as well as the replicated experiment for user participation is designed to improve a visitors understanding of what NASA instrument scientists do.

Informal Evaluation: Voluntary exit exhibit evaluation cards will be used as an evaluation tool to assess if a visitor’s perception of the work of NASA scientists has changed.

Formal Evaluation: Comparison of pre-visit and post-visit student assessment data: What does NASA study? What do NASA scientists do?

Goal 2: Inspire – Meet the scientists, participate in the work of real instrument scientists, engage in an authentic instrument experiment.

Evaluation: Quantitative reporting of audiences voluntarily participating in scheduled In-person, Distance Learning and events with featured exhibit scientists.

Goal 3: Engage – Engage audiences in the work of NASA.

Evaluation: From the “Day in the Life” experience, participants will automatically become engaged in the work of NASA as they will use an authentic instrument built by the GSFC instrument scientists to explore the properties of matter in the same way that the instrument will be used in space to distinguish the properties of black holes, quasars and blazers.

Sallie Smith, an Education Program Specialist with several years experience in evaluation, will lead the evaluation including lessons learned for future efforts.

CONTENT

This proposed exhibit has evolved directly from the two parent science research programs. We aim to inspire young people with the desire for space exploration in order to strengthen the Nations future workforce. The proposed exhibit directly engages the public in sharing the experience of exploration and discovery that is part of the daily work of a NASA scientist. The PI and the detector development team are NASA scientists and a technician, the EPO lead is a NASA employee and the content is all NASA material. The PI will ensure that the content is technically accurate. In addition, the exhibit will be displayed at a NASA visitor center. This exhibition fundamentally addresses the statement “As Only NASA Can”.

Although this is an informal exhibit, we acknowledge that this experience will also support teachers and students needing understanding of the following identified National Science Standards:

Grades 9-12: Scientific Inquiry Standard E

Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

Grades 9-12: Physical Science Content Standard B

As result of their activities in grades 9-12, all students should develop an understanding of the:

- Structure of atom

- Structure and properties of matter

- Interaction of energy and matter

Grades 5-8: Understandings about Science and Technology

Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size and speed. Technology also provides tools for investigations, inquiry and analysis.

Physical Science: Content Standard B

As a result of their activities in grades 5-8, all students should develop an understanding of properties and changes of properties in matter

Transfer of Energy

Light interacts with matter by transmission (including refraction, absorption or scattering, including reflection).

PIPELINE

The “A Day in the Life of a NASA Scientist” Visitor Center experience supports NASA pipeline initiatives as users are provided with direct exposure to the exciting career field of working as an instrument scientist at NASA. The video loop exposes participants to the work performed by scientists in the Astrophysics Science Division lab at the GSFC. Participants engage in NASA mission science as they perform a hands-on experiment using the GSFC built instrument to explore the interactions of energy and matter. This is analogous to what scientists will do once the detector is launched into space in order to better understand black holes, quasars and blazars. The experience directly supports careers in STEM, exposing visitors to career options through participation in this experiment. By users going through a scientific process, using critical thinking skills and innovative technology, it promotes the improvement of STEM skills. Audiences will be provided with links to NASA Mission Science websites.

Interaction with Scientists: Special events are already planned with the instrument scientists of this proposal to inspire audiences through interaction. The scientists have agreed to share their work and lead the exhibit activities for special distance learning events (DLN), student groups, and underserved/under-represented minority groups such as Women in Science.

Promoting Future Instrument Scientists: In the post-activity packet distributed to teachers, students will be encouraged to design their own instrument, identifying what they would like to explore on Earth or in space, how the instrument that they designed functions to collect data, identifying the expected cost for materials and what questions could be answered using the instrument. Teachers will send the best designs to the VC to be displayed. At the end of the first year of operation the proposal team will review the designs received and the top designers will be invited to one of our events for special recognition.

Finally, NASA and GSFC have a number of opportunities for high school and middle school students including summer internships and other educational programs. A visit to the Goddard VC provides students with exposure to these educational opportunities.

DIVERSITY

The Goddard VC draws a diverse student population from Prince Georges and Baltimore County and Washington DC. Both Washington DC and PG county have an approximately 60% Black or African American population and our visitors reflect the population we serve. The VC also serves community groups with mental and/or physical disabilities approximately once a month. The exhibit will be designed to be wheelchair accessible and the video will have both audio and closed-captioning. All handout materials will be available in Braille. As part of the accessibility plan for the VC we are developing an audio tour for the blind that would be available for all visitors and for all exhibits. This would be a no-cost addition to this exhibit as it is part of the overall VC plan.

The experience will be developed in consultation with members of the communities it is intended to serve. We will have focus groups during the first year that will include local middle school children as well as the Women in Science group, that will visit the lab to see the development of the detector and to provide feedback on the exhibit concept.

The PI, as a female scientist, and the EPO Lead, as a female engineer, are dedicated to engaging more women in STEM careers. Toward that end special underserved/under-represented groups will be targeted for the DLN event such as SISTERS, Women in Engineering, etc.

The live DLN event will provide an opportunity for schools across the US including rural and urban Explorer Schools to engage with a female scientist and engineer to gain insight into STEM opportunities.

RESOURCE UTILIZATION

WORK PLAN

During the first year of the award, the project focus will be on building the detector and the development of the EPO plan. The first 3 months of the second year will include the implementation and rollout of the following:

Installation of the detector/chamber

Digital Learning Network module

Design and installation of the display panels

Filming of the looped video

We assume that the first years funding will become available approximately 6 months prior to the renewal date of the parent proposals. Purchasing the equipment, design and build-up of the detector and chamber will take 6 months. Towards the end of the 6 month period we will create the evaluation package.

The second year funding for this EPO project will arrive at the renewal data of the parent proposals. We will design and create the display panels and purchase the exhibit support equipment; panel stands, CO₂ gas, lab supplies etc. The installation and final sign-off by GSFC safety branch will occur three months into the second year. At this time the interactive experience will be open to the public. The public events will occur during the remainder of that year.

IN-KIND DONATIONS

The overall program budget is extremely cost effective. Resources are leveraged within the VC, the Astrophysics Science Division (ASD) and the Office of Education. The building of the detector and chamber for the exhibit will occur in parallel with the work of the parent proposal providing significant economies. The PI and Co-I scientists from the two supporting parent proposals will provide expertise and oversight at no cost. We estimate that the in-kind effort from the instrument team will be a total of 3 weeks effort over two years (\$16.8 K). The EPO Lead will provide expertise and oversight of the exhibit at no cost with an in-kind salary contribution of \$16.8K, which is a total of three weeks effort over the two years. GSFC Astrophysics Science Division (ASD) has agreed to waive the overhead associated with this proposal, amounting to \$5353 over 2 years.

BUDGET

Achieving the goal that visitors to the Goddard Visitor Center will be informed, inspired, and engaged by having a portal into the daily lives of NASA scientists is well worth the total program cost of \$60K. During the two years of operation of the exhibit, over 70,000 visitors will have an opportunity to experience this program. The live events provide additional opportunities and the video has the potential to have a long reaching impact.

The details of the cost of the individual components are broken out in the budget narrative for each year of the program. The labor costs have been minimized by capitalizing on the overlap with the two parent science proposals.

Year 1

In the first year, the labor charges of \$11,225 are for the technical work to build and assemble the detector. This work will amount to 5 weeks effort occurring over several months and capitalizes on the existing expertise of the technician in the ASD lab. As the

detector assembly is completed, the evaluation package will be formalized by the education program specialist over 3 weeks (\$3600).

The equipment costs are broken out below.

The operation of the detector requires 3 high-voltage supplies and 2 low-voltage supplies. These off-the shelf items have been identified and budgeted appropriately (\$3250). The cost of the readout electronics and the detector, of \$5700, has been estimated by the ASD scientists. The electronics will be built in parallel with the electronics developed for the parent research detectors to minimize cost and manpower. All the components for the assembly of the detector housing are off-the-shelf items and will cost \$5490.

The purchase of the radiation sources (\$375) has been negotiated with the GSFC radiation branch. These sources are available from an educational manufacturer, and are very low in radioactivity. The Radiation Safety Officer (D. Simpson) has agreed to support the purchase and installation of the radiation sources and to ensure that all safety requirements necessary are met. S. Boesen, GSFC's safety lead, will ensure the design of the exhibit meets safety requirements. An acceptance safety review will be completed prior to the exhibit opening.

The in-kind contribution consists of the overhead waived by ASD and the in-kind effort of the PI/Co-I scientists and the EPO lead.

Year 2

Labor charges in the second year include \$4939 for 2.2 weeks of technician support to perform the installation and for the maintenance of the exhibit over the second year and for one additional year. \$3600 is included for the support of the Education Program Specialist for 3 weeks effort over the two years of operation to assess the evaluations and to provide feedback for the exhibit.

The equipment costs are as follows:

The detector housing will be filled with 1 atmosphere of CO₂. A constant supply of CO₂ will be needed to sustain the experiment and a switchover system will be required to switch from one gas bottle to another automatically. This system will cost \$3730. The cost of the CO₂ is \$2912/year and is in accordance with the purity required for the operation of the detector and the cost is taken from GSFC stock supplies. This includes the delivery of the gas bottles to the VC. Second year money includes the cost of CO₂ for the second year and one additional year of operation.

The detector will be operated from a PC that will run the software that reconstructs the tracks from the incoming data. The PC in the budget (\$460) meets the requirements as identified from the operation of a similar detector in the laboratory. A large multi-panel monitor has been selected to clearly display each track created by the interaction of the radiation in the detector, the accumulation of the spectrum, and the operational interface. The cost of the monitor is \$3999, but will allow better interactivity for larger groups. The detector and PC will be set-up on the lab-bench with an ESD mat for authenticity. The cost of \$1040 for the gloves, ESD straps, lab-coats, lab bench and ESD mat was obtained

from a laboratory supply store. The cost of \$3120 for materials to sustain the exhibit for an additional year beyond the NASA funding is included in the second year budget.

The cost of \$2000 for the creation of the display panels is from GSFCs Technical Information and Management Services Branch, who produce other displays in the VC. The initial design of the panel will use existing graphics and content from ASD and will be designed by the science team on the parent proposals with oversight from the Education Program Specialist to verify that the content is at an appropriate level. An art supply store has been identified to provide the stands to hold the panels at a cost of \$500. The cost of the video has been priced from GSFC TV at \$2500. This will be played on a DVD and displayed on the monitor that is provided as part of the PC-bundle.

The Astronomy Club and the Women in Science events will be part of the VC calendar and will incur no additional expense. The evening lecture will incur the cost of support staff at the VC (\$500). For hosting a live DLN event the cost is \$500 with no additional cost for webcasting or archiving video on the DLN.

The in-kind contribution consists of the overhead waived by ASD and the in-kind effort of the PI/Co-I scientists and the EPO lead.